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SPILL-PROOF CUP

This invention relates to spill-proof cups and in particular relates to such cups for use by babies or children and the infirm.

The need for spill-proof cups is well known; these are cups with an air-tight lid and a spout which are designed not to leak when the cup is held in a tilted or overturned position by a child, or when the cup falls on its side or even turns over. There are various designs serving this purpose, and these can be broadly divided into four groups:

a) those requiring some deliberate action to close. These suffer from the obvious disadvantage that the baby/child cannot be relied on to operate the closure.

b) Self-sealing, containing a valve. These suffer from the general problem in that the use of the valve is 'wrong' in the sense that the direction in which, in one situation, the flow is supposed to be blocked is the same direction in which, in another situation, the flow is desired. Therefore these valves are either not efficient in blocking the leaks, or they offer an undesirable level of resistance to suction. Many also contain areas which are difficult to clean, and others also contain many components which make the cup expensive.

c) Where an obstruction that covers the exit is pulled away by the suction applied by the drinker. However, this is prone to the venturi effect which tends to partially re-obstruct the exit and possibly induce oscillatory instability.

d) Flow restraint, without a valve, with which the present invention is concerned.

US 4,795,052 and US 4,915,250 describe two similar versions of such a cup. It contains an airtight lid with a spout. The inside aperture of the spout communicates with the interior of the cup by way of a tubular 'chamber' which is disposed in the lid, starts and ends near the spout, and runs (generally along the rim of the lid) from the first half of the lid to the second half of the lid and back again, so that, as specified in US 4,915,250, when the cup is tilted liquid exiting the cup through said tubular chamber would have to rise above the level of the liquid in the container. This can only happen when the liquid is being sucked out, and thus leakage is prevented even when the cup lies on its side. US 4,795,052 specifies another

similar passage between the inside and outside to act as a vent. This eases the suction somewhat but has other disadvantages.

The disadvantage of this arrangement in any practically utilizable form (for example in the product known as the ANSA cup, which uses a tube that is attached to the inside of the spout and runs round along the inside of the rim) is that the inside of this tube cannot be cleaned in a way that is considered necessary for baby feeding equipment: that is, for all surfaces to be accessible to mechanical cleaning action, e.g. by means of a brush or even the finger, especially when milk etc. has solidified inside.

The above mentioned US patents describe a lid with the chamber as a fabrication of two plates, one upper and one lower. This however would either be permanently sealed with the inside of the chamber inaccessible for cleaning, or if detachable it would be impractical to dissemble and reassemble regularly by the user such that the chamber, as disclosed there, is totally sealed everywhere other than at its free end. As noted above, in practice, a tube is used and this is inaccessible to cleaning also.

The present invention seeks to provide a cup improved in the above respects, which is easy to use, spill-proof and easy to clean even when used with solidifiable liquids such as milk.

According to the present invention there is provided a cup including: a sealingly engageable lid having a drinking spout located thereon, a tubular passage formed between inner surface of the lid and/or spout and a detachable member located on the lid, the passage having one end in communication with the inside of the cup and the other end in communication with the outside of the spout and being of such a diameter such that air cannot readily bubble past liquid inside it.

When such a cup is inverted, liquid starts to move downwardly into the passage and the locked air above the liquid expands, thus lowering the pressure. This continues until an amount of liquid has entered the passage with the associated pressure reduction in the air above the liquid just balancing the pressure of the liquid head, upon which further movement of liquid ceases. (The fact that air cannot bubble past the liquid in the passage ensures that the air pressure is

not restored while the cup is inverted or reclined.) Thus the capacity of the passage should be great enough to contain this amount of liquid without reaching the exit and therefore spilling.

Although there will be variations for cups of non-cylindrical shapes, in principle the volume increase (in cc) to give the reduction in air pressure to support a given head of liquid (e.g. water) is given by: H x V, where V is the volume (in litres) of air inside the cup, and, with the cup inverted, H is the height (in cm) of the water level above the exit of the spout. This varies according to the water level, but usually at a maximum with cup about half full. Thus, in the preferred form of the invention, the volume of the passage is greater than the maximum value of HxV.

The spout is preferably tapered so easily to receive the detachable member, and is preferably conical, most preferably in the for of a truncated cone. The detachable member is preferably in the form of a plug which fits into the inside of the spout and is sealingly engaged thereto, e.g. by an interference fit. The plug will generally therefore have the the same or similar outside configuration as the inside of the spout. The plug preferably has an elongate channel on its surface which, in cooperation with the inside of the spout, forms the passage. However, the channel could instead be formed on the inside of the spout or on both the spout and the plug, or indeed between two or more parts which make up the plug . In any event, the plug is easily removable and replaceable by a user, enabling the inside of the passage to be exposed for mechanical cleaning thereof. It is usually more convenient, and therefore cheaper, to manufacture the device with the channel formed in the plug. This is also better for cleaning purposes. The plugr is preferably made from a resiliently compressible material, such as an elastomer, and may advantageously be moulded therefrom.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates the lid of a drinking cup in side elevation (a), end elevation (b) and bottom plan (c) views;

Figure 2 shows the plug of the invention in side (a) and end (b) elevation;

Figure 3 is a diagrammatic side view of a typical cup and lid;

Figure 4 is a similar view to figure 1 (b) of second embodiment of the invention; and

Figure 5 (a) is a similar view to Figure 2(a) of the second emodiment, and (b) is a bottom elevation.

Referring to the drawings, and in particular Figures 1 and 2, a lid 10 has sides 12 which are sealingly engagable with a cup in a manner known *per se*. The lid has a spout 14 located eccentrically so as to be convenient for drinking from. The spout 14 is in the shape of a truncated cone, preferably flattened (i.e. with an oval cross-section), and with a small bore 16 at the top. A detachable member, in the form of a plug 18 moulded from an elastomer, has a helical channel 20 around its exterior surface and it also has an outline matching the inside of the spout's cavity. The ridges 22 between respective channel portions are such as to make sealable contact with the inside surface of the spout's cavity. The top end of the channel 20 is in communication with the bore 16 in the top of the spout, and therefore the outside of the cup, and the bottom of the channel communicates, in use, with the interior of the cup.

Preferably the lower (wider) end of the plug 18 has integrally formed or attached to it a downward pointing extension, for instance in the form of a tab or a ring 24, with which the plug can be pulled out of the spout cavity for cleaning. This also adds to the size of the plug as a whole to conform with regulations governing the minimum size of objects which a baby might introduce into its mouth. When the plug is inserted into the spout's cavity, a tubular passage is formed by the channel 20 which is sealed everywhere except at its two ends. The diameter of the passage is such that air is prevented from entering past the liquid, for example a maximum diameter of approximately 3mm. When the cup is inverted, liquid starts to enter the tubular passage, thus causing the air inside the cup to expand and thus reduce in pressure. When the sub-pressure thus created inside the cup equals the pressure of the water-head between the upper level of the liquid and the lowest point that it reaches in the tubular passage, the ingress of liquid into the passage ceases. The volume of the canal is such that at this point

the liquid has not yet reached the outlet of the bore 16. Preferably, the volume of the passage should be somewhat larger so as to absorb the effect of downward shaking of the cup. For example, for a 200cc cup of typical shape, the volume of the passage would be approx. 1.2c.c. When the cup is returned to the upright position the sub-pressure retracts the liquid in the passage ready for the next inversion.

Referring now to Figure 3, a 250 c.c. cup 24 is shown of typical shape, having the lid 10 and spout 14, the latter containing the plug of the invention. It is illustrated inverted, with a water level of height H cm above the spout bore 16, and an air space of volume V.

The height H and volume V for various fill levels for the above cup are given in the table below:

H (cm) of water	V (litres) of air	Min. passage vol. HxV (cc)
4.0	0.226	0.905
5.0	0.195	0.975
5.5	0.180	0.991
6.0	0.165	0.993
6.5	0.151	0.983
7.0	0.137	0.962
8.0	0.111	0.886

As can be seen from the above table, the greatest volume at approximately half full is 0.993 cc. Accordingly, in order to allow some leeway as described above, a passage capacity of 1.2 cc might be employed. If the passage is of the maximum 3mm diameter, its cross sectional area would be approx. 0.07cm^2, so for a volume of 1.2 cc its length would need to be about 17 cm. This is easily achieved with a helically formed channel 20 on the plug 18. The configuration of the passage does not need to be helical but can be any shape that is convenient

and yet allows the relevant length to be achieved. A helical channel is a very compact and convenient way of doing this.

Referring now to Figures 4 and 5, and using like numerals for like parts, the spout 14 in this case is a tilted truncated cone. In a particular example, the wall thickness of the cone is 1.5mm, with an outside diameter at the top of 13mm. The plug 18 is in the form of a hollow truncated cone also, with a helical channel 20 about its exterior as before. The bottom of the plug 18 terminates in a hollow cylindrical portion 26 which provides a grip for removing the plug from the spout 18. The cylindrical grip 26 may have segments 28 cut out to further lighten it and avoid liquid being trapped inside when the cup is inverted. Other forms of grip could be used.

In this example, the height of the plug is 27mm, its outside diameter at the top is 10mm and its OD at the bottom 21mm. The width of the channel is approx. 3.2mm, the width of the ridges between the channels is approx. 1.2mm and the number of turns is approx. 5, to give the necessary channel length. The cone half angle is approx. 11.7°.